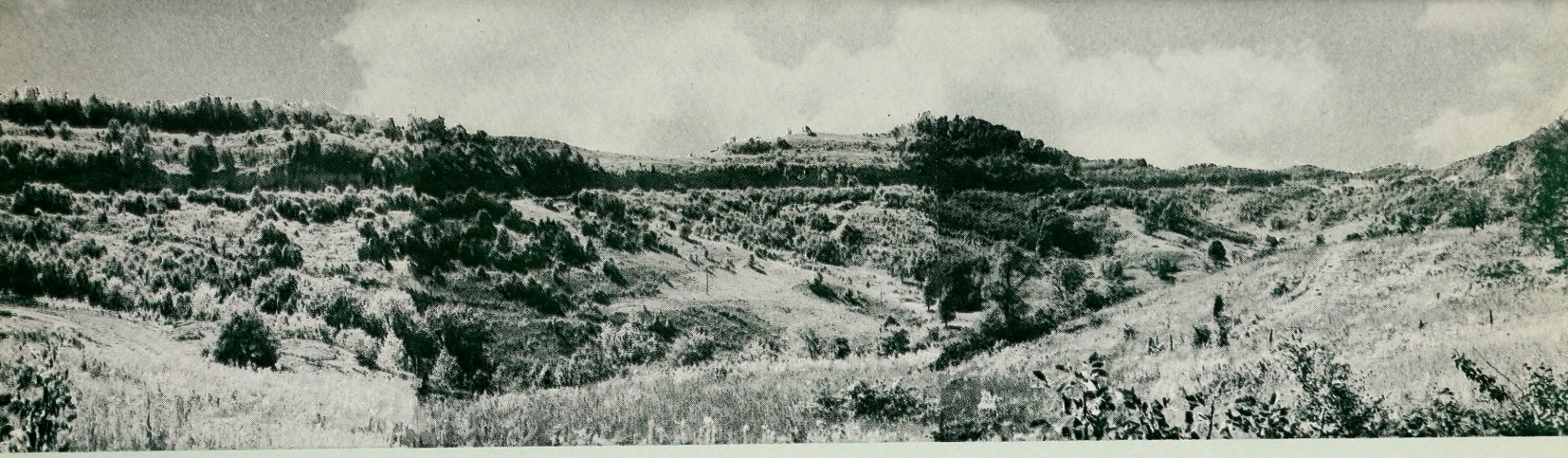

# Results of Revegetation of Strip Mine Spoil by Soil Conservation Districts in West Virginia

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
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## THE AUTHORS

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## PHOTOGRAPHS

The photographs used on the cover and in this bulletin were taken by personnel of the Soil Conservation Service, United States Department of Agriculture.

## COVER PICTURE

A good stand of black locust and sericea lespedeza on a very long spoil area in Harrison County.

# FOREWORD

THE STRIP MINE operator is responsible for reclaiming strip mined land. After backfilling and grading of spoil has been approved, Soil Conservation Service technicians make a planting plan of the area to be revegetated. The operator may do the revegetation work or he may enter into a contract with the Soil Conservation District in the area of his operation to do this work.

This bulletin presents an evaluation of revegetation work by Soil Conservation Districts for the past several years.

Soil Conservation Districts have been successful in improving the reclamation of many spoil areas; nevertheless, there is still much room for improvement. Preplanning; the judicious handling of overburden; the control of drainage during mining operations; and covering of acid-forming materials during backfilling and grading can be of great help in the revegetation of disturbed areas.

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# SUMMARY

The Nation's first strip mine reclamation law was enacted by the West Virginia State Legislature in 1939. This set the stage for future legislation and continued experimentation and research in the field of revegetation of strip mine spoil.

The Soil Conservation Districts were doing reclamation work on spoil areas prior to 1950. In 1953 the Districts began entering into contracts with surface mine operators on a voluntary basis to do the revegetation work. Under the present program the Soil Conservation Service technician develops a revegetation plan on each permit area after the grading is completed and before the planting is done. The operator has a choice of doing his own revegetation work according to this plan or he may contract with the Soil Conservation District to do the work. Practically all of the revegetation work is being done by the Districts at this time. The number of acres of surface mined land revegetated, with one exception, has escalated annually and calendar year 1966 will show an even greater increase.

This evaluation of revegetation on strip mine spoil is divided into two categories: (1) The results from the use of woody plants comprising about 90 per cent of the area observed and (2) the results from the use of grasses and legumes comprising about 10 per cent of the area observed.

The following report is an attempt by the authors to record the results of a six-year observation and evaluation of the plantings on strip mine spoil done by the Soil Conservation Districts in West Virginia. There are also statements in regard to some of the more important items to consider, based upon the experience of the Soil Conservation Districts, in establishing and maintaining satisfactory vegetative cover on these critical areas.

# Results of Revegetation of Strip Mine Spoil by Soil Conservation Districts in West Virginia

ROSS H. MELLINGER, FRANK W. GLOVER JR.,
AND JOHN G. HALL

STRIP MINING of coal in West Virginia began on a domestic basis more than a century ago. Coal was uncovered in stream beds and other easily accessible places by hand and by horse-drawn scoops. However, it was not until 1938 that commercial strip mining, as it is now known, produced any appreciable amount of coal. Production by this method steadily increased with the demand for coal created by World War II, and reached its peak in 1947 when 18 million tons were produced. The trend was downward until 1962 when 5,206,263 tons of coal were mined. Production is again increasing with 8,444,316 tons mined in 1964. More than 200 million tons of coal have been strip mined in West Virginia since 1941.

The need for legislation regulating strip mining of coal was recognized with the enactment of the first strip mine law in 1939. This law required some regrading of strip mine spoil but did not require planting or seeding. There were revisions in the law in 1945, 1959, 1961, 1962, and 1963. The present law requires that strip mine spoil areas be regarded and that a satisfactory stand of vegetation be established on reclaimed areas. Some areas may also be reclaimed for other uses. This law permits the strip mine operator to contract with his local soil conservation district for the establishment of vegetation on spoil areas.

Since 1954, the Soil Conservation Service has furnished technical assistance to districts in revegetation work. This consists of classification of the spoil, preparation of a revegetation plan, and technical assistance needed to carry out the plan. This activity has been increasing (Table 1).

TABLE 1

STRIP MINE SPOIL

Total To-Date Planned and Established (State)

| Dates | Number of Plans | Number of Acres Planned | Number of Acres Planted and Seeded |
|---|---|---|---|
| 1/1/54-6/30/58 | 23 | 385 | 193 |
| 7/1/58-6/30/59 | 70 | 1,496 | 239 |
| 7/1/59-6/30/60 | 128 | 3,815 | 523 |
| 7/1/60-6/30/61 | 207 | 3,987 | 1,769 |
| 7/1/61-6/30/62 | 313 | 6,299 | 3,536 |
| 7/1/62-6/30/63 | 381 | 10,528 | 3,088 |
| 7/1/63-6/30/64 | 322 | 8,160 | 3,454 |
| 7/1/64-6/30/65 | 443 | 10,672 | 4,324 |
| State Total | 1,887 | 45,342 | 17,126 |

*Figure 1. Back filling along face of cut on Pittsburgh Coal in Barbour County.*

Because of the increased activity, the Soil Conservation Service in cooperation with the West Virginia University Agricultural Experiment Station made observations over a 6-year period on strip mined areas. On all these areas the planting and/or seeding had been done by soil conservation districts. A critical evaluation of vegetation growing on the different areas consisted of actual counts as well as visual estimates to determine survival performance and stand density of the planted species.

The objective of conservation planning of strip mine spoil is primarily that of stabilization of the surface area. (WV-488-9) Other objectives, even though of secondary importance, should be planned when compatible with the primary objective. These secondary objectives are: screening unsightly areas, growing products for economic use such as hay or wood, development of wildlife habitat by use of plants that will increase food and cover, and recreation.

*Figure 2. Planning revegetation of strip mine spoil in Gilmer County by work unit conservationist.*

*Figure 3. Strip mining operation in Monongalia County after coal has been removed but before back filling.*

## USE OF WOODY PLANTS

The stabilization of spoil material with woody plants depends upon the successful establishment of a well distributed stand of adapted trees or shrubs. Table 2 is a summary of the observations made on the density and distribution of the planted and seeded stands. These findings clearly show the advantage in favor of *planting* rather than seeding to establish woody plants.[1] Continued use of direct seeding is justified only if the area is classified as too steep and/or stony to plant.

Poor survival and distribution in *planted seedling stands* was nearly always caused by low pH (below 4.0) and occasionally by grazing. Causes for poor establishment and distribution of *seeded stands* could not be determined except where acidity was below pH 4.0. (WV-630-10)

Uncontrolled grazing has severely damaged a number of plantings. Protection from livestock is essential for adequate establishment of trees and shrubs and stabilization of spoil.

[1] A more comprehensive survey on the results of direct seeding of black locust is reported in W. Va. Agr. Exp. Sta. Bull. 440, *Establishment of Seeded Black Locust on Spoil Banks*, by James H. Brown and E. H. Tryon.

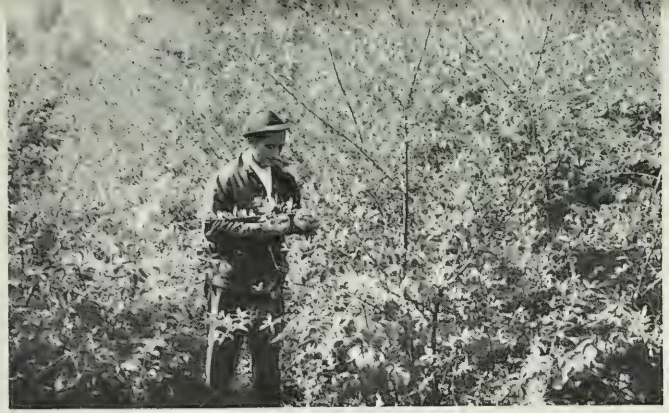

*Figure 4. A vigorous stand of autumn olive in Preston County provides food and cover for wildlife.*

*Figure 5. Scotch, white and red pine planted on leveled area. Trees average about 4 feet in height. Elevation is between 1,900 and 2,000 feet.*

*Figure 6. Extremely steep overcast slope seeded to black locust and sericea lespedeza—Raleigh County.*

*Figure 7. Area where locust seeding failed—Raleigh County.*

## WOODY PLANTS USED FOR REVEGETATION[2]

The following species were used for revegetation work (black locust was the only species used for direct seedings):

| | |
|---|---|
| **Black locust** | **Scotch pine** |
| **Autumn olive** | **White pine** |
| **Virginia pine** | **Red pine** |
| **Shortleaf pine** | |

Hardwood tree species other than black locust have had only limited use by soil conservation districts in West Virginia and could not be evaluated. However, experience in other states under similar spoil conditions indicates that other hardwoods perform well, especially in mixture with black locust.

When there is a *critical need for quick stabilization,* plants which have high initial vigor, ability to provide quick crown closure and litter deposition, and nitrogen-fixing ability are ideal. For this purpose *black locust,*

[2] Use of tree species on strip mined areas has been reported in W. Va. Agr. Exp. Sta. Bull. 473, *Success of Tree Planting on Strip Mined Areas in West Virginia,* by James H. Brown.

**TABLE 2**
**Summary of Strip Mine Spoil Areas Seeded and Planted**

| | Seeded (Black Locust) | Planted (All Species) |
|---|---|---|
| Number of areas | 89 | 125 |
| Acres | 974 | 1,564 |
| Average density* | 49% | 74% |
| Distribution†—Spotty | 61% (591 acres) | 15% (234 acres) |
| Distribution—Uniform | 39% (389 acres) | 85% (1,331 acres) |

*Per cent density $= \frac{\text{number plants alive}}{\text{Number planted}} \times 100 =$

† Distribution of stands were rated as spotty if there was more than one area per acre (¼ acre or larger) below 60 per cent density.

which has all of the desirable characteristics, has been the best performer. However, on spoil having a pH below 6.0 black locust suffers severely from borer damage. This severely limits the opportunity for a wood crop. Improved dominant stem strains of black locust show promise of being more resistant to borers and may be capable of producing post material.

Autumn olive, a medium-sized shrub, is a vigorous plant on a wide variety of spoil conditions. It runs a close second to black locust for ability to survive and

*Figure 8. Effect of cattle grazing on establishment and growth of seeded black locust. Left of fence protected. Right of fence continuously grazed since seeding.*

grow quickly. However, it does not deposit as much litter as black locust. It has value for wildlife food and cover, and helps improve the appearance of spoil areas.

Several species of *pines* have been found suitable for planting when erosion is not active to the point where seedlings will be washed out of the ground. This usually limits the use of pines to leveled areas or to short slopes and coarse-textured spoil. White pine, Virginia pine, shortleaf pine, Scotch pine, and red pine are all making satisfactory growth on spoil. Virginia and shortleaf pine have the highest initial vigor; Scotch and red pine are next; white pine is the slowest to get started but once established it makes excellent height growth comparable to field plantings. The pines are slow to develop litter until the crowns close. They are promising species for wood crop production. They are also useful in improvement of wildlife habitat and to screen highwalls and other unsightly areas. (Figure 11, white pine; Figure 12, Va. Pine; Figure 13, red pine; Figure 14, shortleaf pine.)

Trees and shrubs which seed in naturally contribute to increased cover and to the potential for wood crop production. The volunteer tree species that seed in

*Figure 9.*

*Five-year-old black locust stand from tree seedlings. Trees are about 20 feet tall. There is considerable variation in form—Preston County.*

*Figure 9a.*

*Accumulation of litter under black locust (five years old) shown in preceding picture.*

*Figure 10. Dominant stem strain of black locust seven years old. Trees average 3 inches diameter breast height, 22 feet high. Some are forked but most show excellent form— Fayette County.*

*Figure 11. White pine on leveled spoil area. Note volunteers of birch, ash and maple filling in openings. This spoil area is bounded on both sides by woodland — Preston County.*

*Figure 12. Virginia pine trees, five years old, free from insect or disease damage. Average height is about 6 feet. They are beginning to reproduce. Compare to red pine on right of picture planted same time but infested with shoot moth. Elevation is between 1,900 and 2,000 feet.*

*Figure 13. Red pine planting, five years old, on leveled area exposed to sweeping winds at 3,000 feet elevation. Trees average about 4 feet tall and are free of insect or disease damage.*

*Figure 14. Shortleaf pine, seven years old, ranging from 5 feet to 10 feet high.*

most frequently are black birch, sycamore, aspen, black locust, sassafras, red maple, and white ash (Figure 15).

Many lessons have been learned by soil conservation districts as a result of experience. They have found the following among the more important items to consider in tree and shrub planting on strip mine spoil:

1. *Planting stock*—Selection of proper grade or size of plants is important. Seedlings need to be of such size that root systems are well developed but plants not too large for efficient planting.
2. *Storage and handling of planting stock*—Early spring delivery (late February or early March) combined with use of cold storage facilities has proved to be the best way of handling planting stock. Where cold storage facilities are not available, a good centrally located heeling-in place should be chosen. Careful heeling-in procedures should be followed. Planting stock should then be taken to the job daily under cover of moist moss or sawdust.

*Figure 15. Volunteer birch on leveled area of strip spoil. Has been interplanted with white pine and black locust—Raleigh County.*

3. *Equipment*—The planting mattock and canvas tree planting bag have proved to be the best combination for efficient planting under a wide variety of spoil conditions. Heavy-duty planting machines have also been useful and efficient for planting large, leveled spoil areas that are not too stony. (WV-761-3)
4. *Organization of planting crews*—The one-man unit system, whereby each man does his own digging and planting, is best. Six to twelve men under one foreman makes an efficient planting crew. (WV-1298-4). Larger crews can be used if reliable working sub-foremen are available. Planting along the long axis of spoil is more efficient than planting from toe of overcast to highwall. This arrangement also lends itself to alternate row or hand planting of mixtures of more than one species.

## USE OF GRASSES AND LEGUMES

About 10 per cent of the spoil areas observed, located on the level portions of the spoil, were seeded to mixtures of grasses and legumes. (WV-177-10)

Both alfalfa-orchardgrass and birdsfoot trefoil grass mixtures have been satisfactory. The birdsfoot trefoil

*Figure 16. West Fork Soil Conservation District tree planter in operation—Lewis County.*

*Figure 17. Using line and pole method to install spacing trials on hardwoods and conifers. Spacings of 6 x 7 feet, 8 x 8 feet and 10 x 10 feet are on trial. U. S. Steel job—McDowell County.*

*Figure 18. Pittsburgh Coal strip regraded and planted to alfalfa. This area is producing several good cuttings of alfalfa hay each year —Harrison County.*

*Figure 19. This uniform stand of Birdsfoot trefoil is eighteen months old. pH range 6.0 to 8.0 at time of seeding—Harrison County.*

TABLE 3

| Mixture Seeded | No. Locations Seeded | Total Acres | No. Locations Managed for Hay | Acres in Hay | No. Locations Managed for Pasture | Acres in Pasture |
|---|---|---|---|---|---|---|
| Alfalfa-grass | 10 | 102.40 | 5 | 62.60 | 5 | 39.80 |
| Birdsfoot-grass | 4 | 39.50 | 1 | 17.00 | 3 | 22.50 |
| Total | 14 | 141.90 | 6 | 79.60 | 8 | 62.30 |

and tall fescue mixture has grown well on several areas in Harrison and Lewis counties on spoil material that has a pH of 6.0 or higher (Figure 19).

Table 3 shows one-year observations of total acres seeded to grass-legume species, and acres managed for hay and acres managed for pasture.

## OBSERVATIONS ON GRASSES AND LEGUMES

1. More forage was produced on the areas managed for hay than on those managed for pasture.
2. The ground cover was more effective for those stands managed as hay due to increased growth and vigor of plants making up the stand.
3. Stand counts of the seeded species were frequently higher on the pastured areas. Heavy grazing had undoubtedly caused much reduction in growth and vigor of individual plants.
4. Soil acidity limits the growth of grasses and legumes on most strip mine spoil areas. Most sites have some areas with no vegetation. pH tests on

bare areas show values ranging from 2.6-3.7. Soil acidity may limit growth more than original tests indicated. We have observed areas that became more acid after original tests. Observations on one area in Barbour County supports current recommendations pertaining to pH. By current specifications seeding of grasses and legumes was not recommended. The landowner applied the necessary limestone so that sericea and tall fescue could be established. Even with fertilization and liming there are still some very acid areas where growth of sericea and fescue is not satisfactory.

5. Stone on or near the surface of most leveled strip mine areas is a serious limitation to the seeding and harvesting of hay and pasture species.
6. To maintain grasses and legumes, adequate fertilizer should be applied as well as lime where and when it is needed.